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THE RECORDING QUIZBOARD:

A DEVICE FOR EVALUATING INTERPRETIVE SERVICES

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ABSTRACT

Describes design and use of recording quizboard which records right and wrong answers to questions based on visitor center exhibits. This helps determine how well exhibit messages are reaching visitors. Initial results indicate that taped messages are more effective than those a visitor must read.

Keywords: Exhibits, education, natural history.

The author is leader of the Environmental Interpretation Research Project maintained by the Pacific Northwest Forest and Range Experiment Station, Forest Service, U. S. Department of Agriculture, in cooperation with the University of Washington, Seattle.

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INTRODUCTION

As more and more areas have been set aside for recreation or for their natural, scenic, or historic importance, the number of programs and facilities designed to interpret these areas has also grown. The prevalence and popularity of these interpretive services show that both administrators and visitors consider them worthwhile. Yet there are few criteria for determining how worthwhile.

One of the great needs in the field of interpretation is to evaluate effectiveness. Do facilities and programs really have the effect they are intended to have? Interpreters have learned much by careful observation of visitors' reactions to these facilities and programs, but they could learn even more if visitors had a convenient way to register their reaction to interpretive services. Such "feedback" from visitors is needed to help the interpreter know how well he is doing and what changes might be useful.

As one effort to provide this kind of feedback, a recording quizboard was developed and tested (fig. 1). This simply presents the visitor with four multiple-choice questions and records his answers with electric impulse counters. When the questions are based on information provided by interpretation, answers indicate what ideas are or are not reaching the visitors who play the quizboard. When changes are made in a presentation, the quizboard can quickly detect whether the communication of specific information was improved.

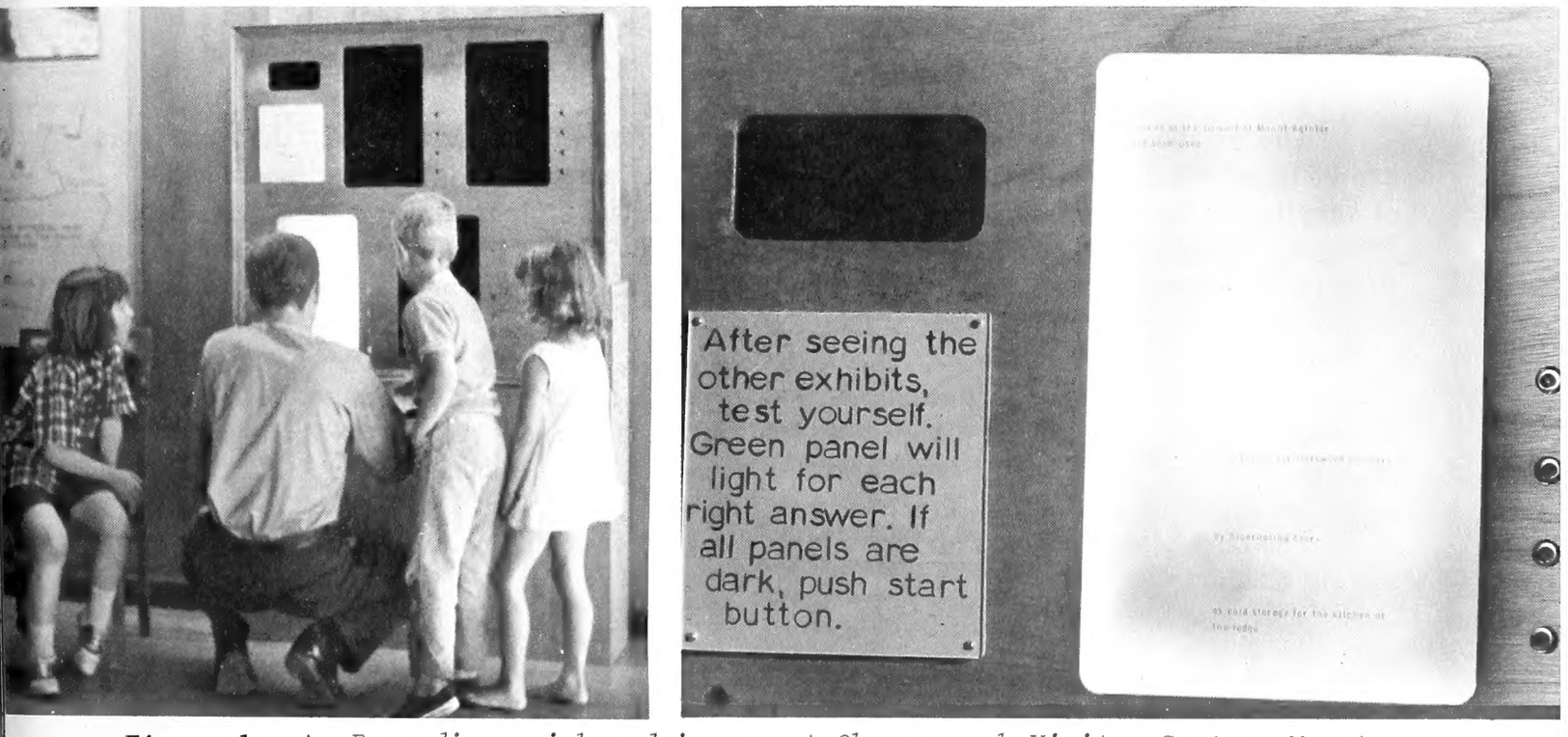


Figure 1.--A, *Recording quizboard in use at Ohanapecosh Visitor Center, Mount Rainier National Park;* B, *question arrangement on backlighted panel.*

CONSTRUCTION AND OPERATION

The basic plan of the recording quizboard is simple. Four questions--each with four answer choices--are presented so that visitors can respond by pushing buttons. Unknown to the visitors, electric counters record their responses and provide a total count of correct and incorrect responses to each question. Thus, what visitors consider a game becomes a feedback and evaluation device for the interpretive planner.

The circuitry of the quizboard is designed so that only one panel is lighted and only one set of buttons is energized at a time. When a question is correctly answered, that question panel darkens, the next question panel lights up, and a green panel reading "right answer" lights up (providing reinforcement to the visitor).

Experience with an earlier version of the recording quizboard showed that some visitors--especially children--would push "correct" buttons repeatedly to see the green panel light up. Thus, the one-at-a-time panel lighting is important. This is accomplished by a rotating relay. As shown in the wiring diagram (fig. 2), additional relays are used to handle the amperage needed for counters and to avoid arcing on the push-buttons. A time delay relay is used to assure proper timing of other components.

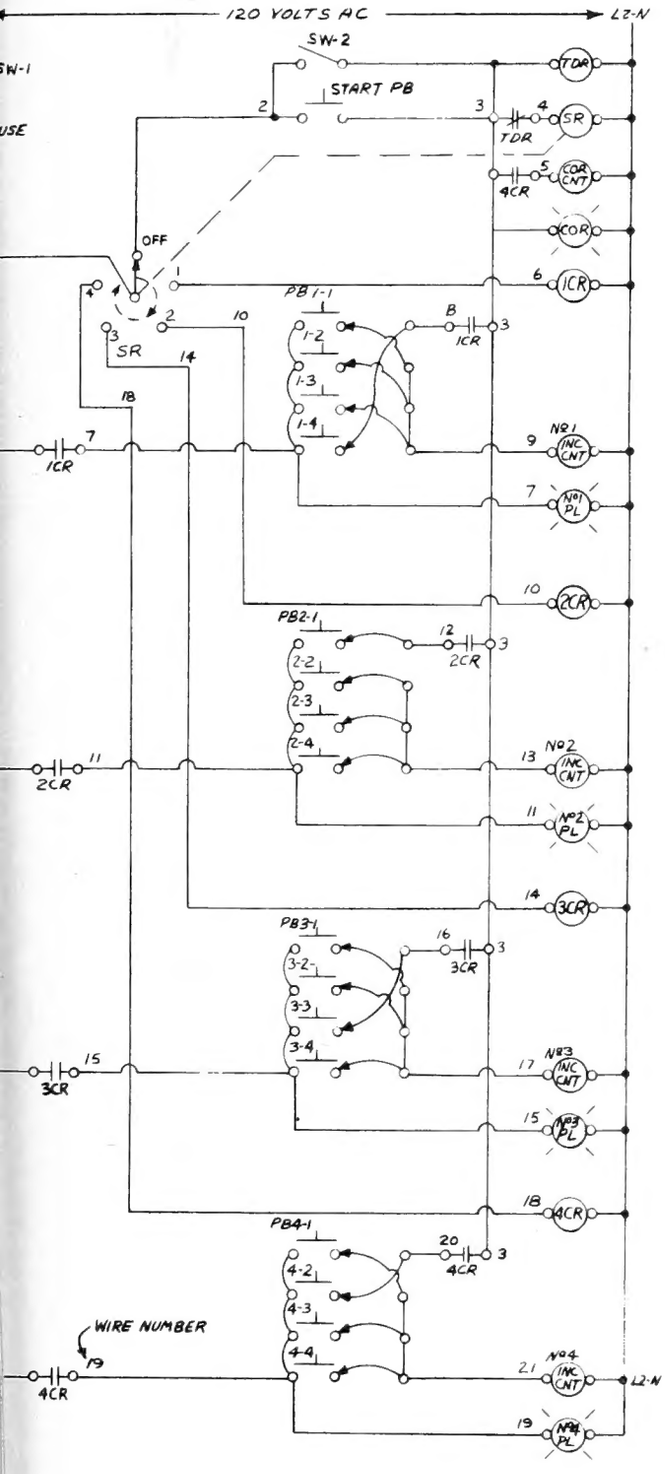
Because the "correct" button for a question must be pushed before the next question panel will become operative, one "correct" answer counter is sufficient to record the number of four-question sequences completed; however, a separate "incorrect" counter is required for each question (fig. 3A).

Correct and incorrect answer positions can be quickly changed by arranging 16 plugs on a small wiring board (fig. 3A). A green plug for each panel corresponds to the "correct" answer position and three red plugs correspond to the "incorrect" answer positions for that panel.

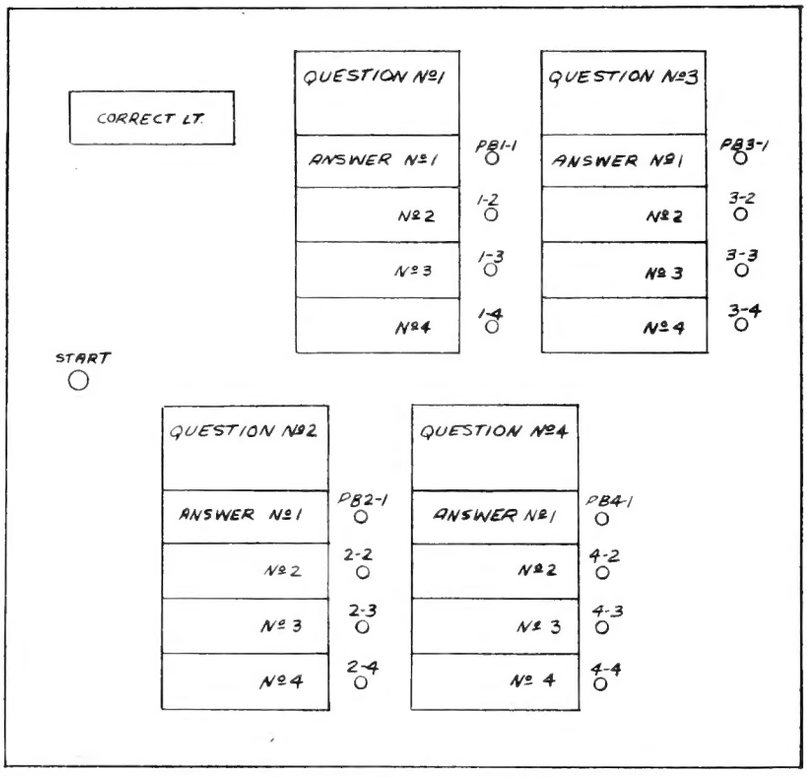
The quizboard was also designed for quick changes of question material. Questions can be typed (in oversize type) on tracing paper that is sandwiched between two sheets of acrylic plastic--a transparent gray sheet in front and a clear sheet in back (fig. 3B). The gray plastic sheet covering each question insures that it is readable only when illuminated from behind. The "sandwiches" are quickly slipped into the quizboard face which is removable (fig. 3C).

Each question panel is lighted by two showcase lights mounted against reflectors made of sheet aluminum (fig. 3D). A 40-watt bulb illuminates the "correct answer" panel. Wood and sheet metal form boxes to separate panel lighting.

The cost of components and materials for the recording quizboard was approximately $215.



WIRING DIAGRAM

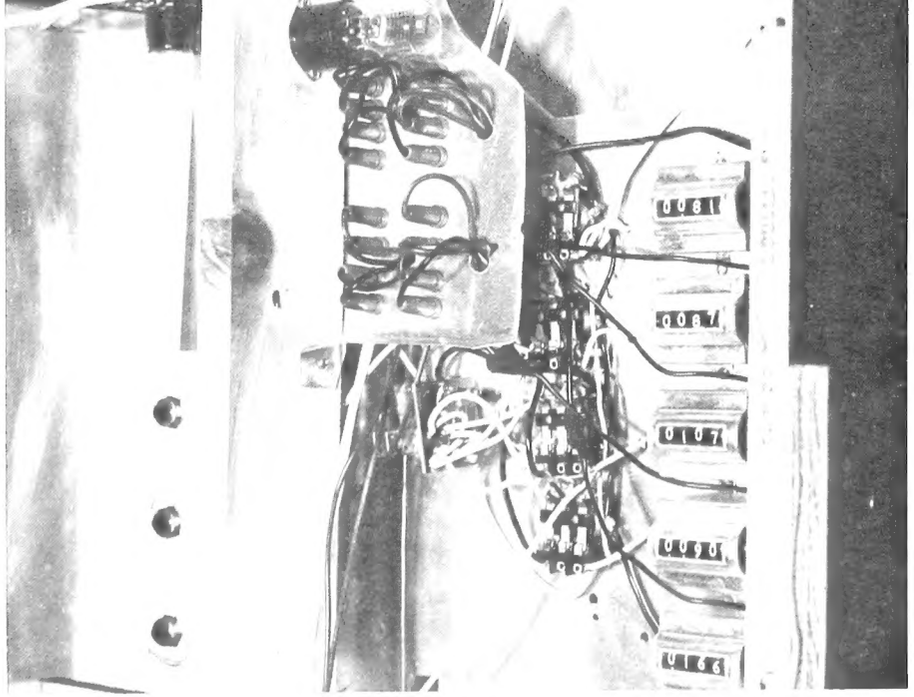


PANEL ARRANGEMENT
NOT TO SCALE

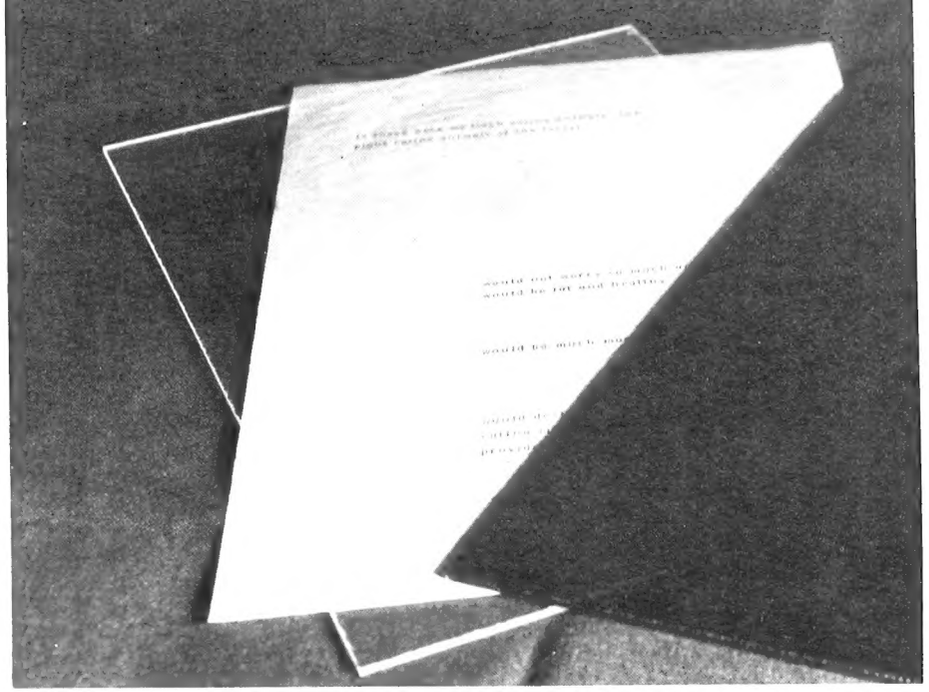
LEGEND

- SW1 & SW2 — TOGGLE SWITCH — SPST — 6 AMPS AT 125 VOLTS.
- FUSE — 5 AMPS.
- SR — STEPPING RELAY — 10 STEPS — 120-VOLT COIL — PRINTED CIRCUIT BOARD SWITCH RATED .25 AMP. NOTE: WIRE POINTS 1 &6, 2 & 7, 3 & 8, 4 & 9, AND 5 & 10 TOGETHER FOR 5-STEP ACTION.
- ICR — CONTROL RELAY — 3PDT — 10 AMP CONTACTS — 120-VOLT COIL. RELAYS 2CR, 3CR, AND 4CR ARE THE SAME.
- ICR — RELAY CONTACT — NORMALLY OPEN.
- RELAY CONTACT — NORMALLY CLOSED.
- TDR — TIME DELAY RELAY — SPST — NORMALLY CLOSED — 2-SECOND TIME DELAY — 115-VOLT COIL.
- INC CNT / COR CNT — COUNTER — DIGITAL WITH 4 DIGITS AND MANUAL RESET KNOB — 120-VOLT COIL. INC. = INCORRECT. COR. = CORRECT.
- J1-1 — JACK (for panel 1, position 1).
- BANANA PLUG.
- PUSHBUTTON — SPST — NORMALLY OPEN — 3 AMPS AT 125 VOLTS.
- COR — CORRECT ANSWER LIGHT — 120 VOLTS.
- NO1 PL — CORRECT PANEL LIGHT FOR NUMBER INDICATED — 120 VOLTS.

Figure 2.--*Wiring diagram for the recording quizboard.*



A



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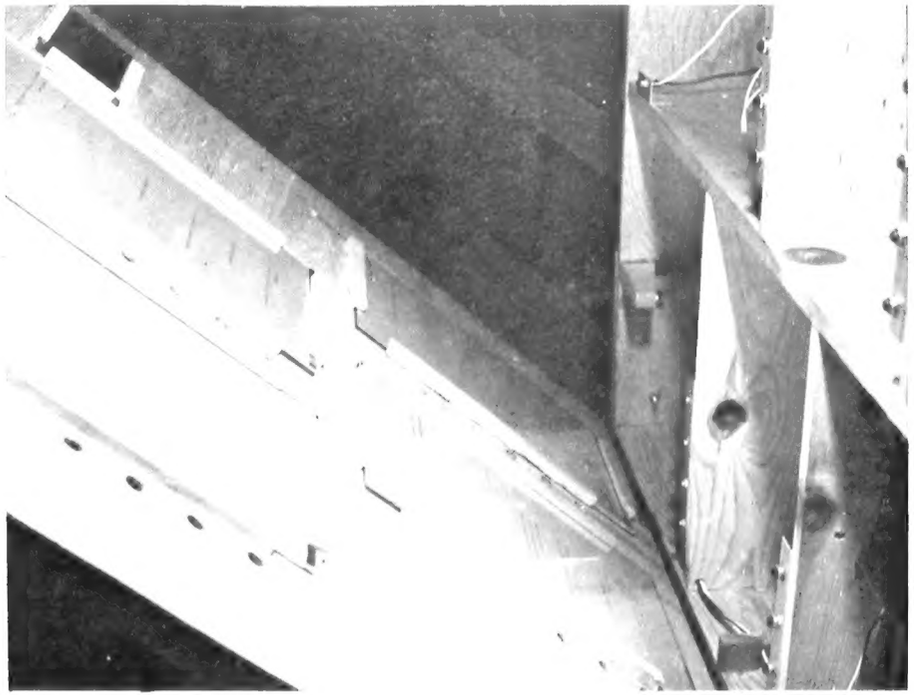
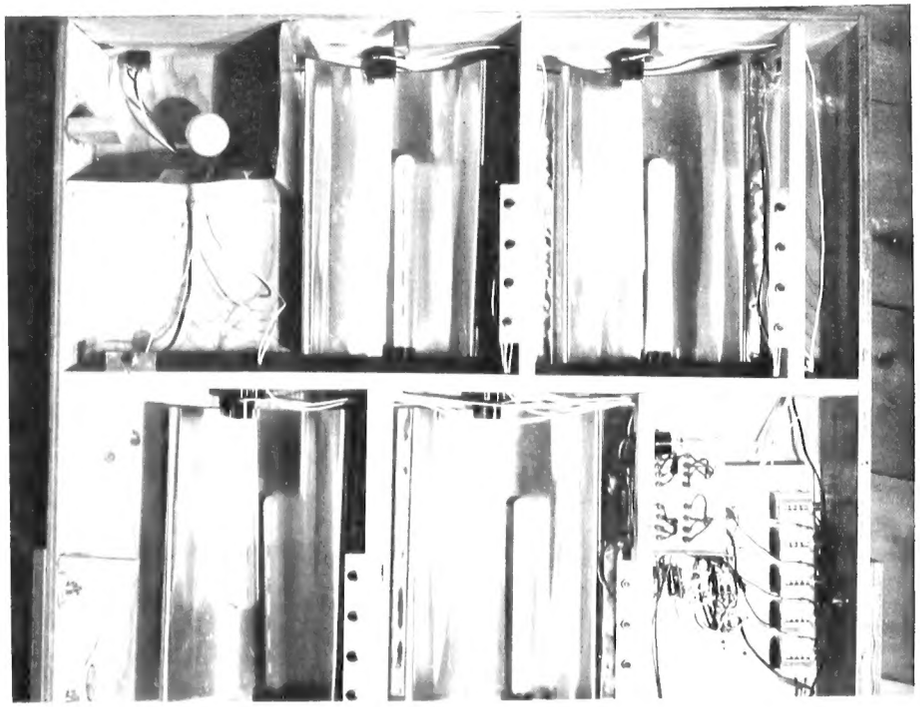


C



D

Figure 3.--*Construction detail for the recording quizboard: (A) Counters and the wiring board for defining which buttons operate which counters. Each group of four plugs includes a green plug for correct answer and three red plugs for incorrect answers. (B) Each answer panel contains a "sandwich" of tracing paper and sheets of acrylic plastic. (C) The removable quizboard face permits answer panels to be quickly changed. (D) Each panel fits over a box with lights and reflectors for illumination.*

TESTING

The quizboard was tested at the Ohanapecosh Visitor Center in Mount Rainier National Park during August and September of 1969 and late July and August of 1970. This is a small visitor center devoted to interpreting the interrelationships of various life forms within the lowland forest portion of the Park. Exhibits are of excellent quality; and except for those designed to orient the visitor, all are pertinent to the central theme of the visitor center.

The 10 questions shown in table 1 were written to measure visitors' retention of specific information presented in the exhibits. The main purpose of testing was to see if the quizboard could distinguish between the effectiveness of different presentations. Questions were therefore based on a variety of exhibits incorporating different presentations. Specific comparisons were made between audio and text presentations and between various combinations of three-dimensional (3-D) and such "flatwork" presentations as photos and drawings. Questions 1 and 2 (for taped narration) were based on the recorded message of the key exhibit of the center, a diorama presenting mounted mammals and birds in a lifelike setting. When a button at this diorama was pushed, a recording explained predator-prey relationships and interactions between the plant and animal communities of the forest. Lighting was coordinated with the message to illuminate whichever animals were being discussed.

Questions 3, 4, and 5 (for 3-D and text) were based on the texts of small signs around a relief model of Mount Rainier National Park. Questions 6, 7, and 8 (for combinations of 3-D, flatwork, and text) were based on texts in three display cases interpreting the three major trees of the area--Douglas-fir, western redcedar, and western hemlock. These cases included photographs and drawings along with such 3-D objects as upright sections of bark, mounted birds, and Indian artifacts. Questions 9 and 10 (for flatwork and text) were based on panels that included only photographs, drawings or paintings, and text.

For the 1969 tests, these questions were used in three sets of four as follows:

1, 2, 9, 10;
1, 3, 4, 5; and
1, 6, 7, 8.

Results for 1969 were distorted because of a faulty counter but suggested that visitor responses changed after Labor Day, when an older group predominated in the adjacent campground. After Labor Day the proportion of correct answers went up for all questions. The 1969 results also indicated that the position of the correct answer among the four choices might be affecting results.

Because of the 1969 results, procedures were changed in 1970. To eliminate position effects, each of the 10 questions was written four ways, with the correct answer placed in each of the four possible positions. This gave a total of 40 questions presented in 12 sets of four. These were presented so that (1) two versions of the same question were never used at the same time, (2) a version of question 1 was included in

Table 1.-- *Questions used with the recording quizboard, Ohanapecosh Visitor Center*[1/]

Number	Question	Answer choices	Position
1	If there were no flesh eating animals, the plant eating animals of the forest	would not worry so much and be fat and healthy	a
		would be much more numerous	b
		would destroy their food supply by eating more than the forest could produce	*c*
		would not be affected	d
2	The creature most likely to be found eating berries is	the coyote	a
		the grouse	*b*
		the bobcat	c
		the martin	d
3	Each National Park is established by an Act of Congress. Mount Rainier was	established in 1890	a
		established in 1899	*b*
		established in 1906	c
		established in 1916	d
4	Caverns at the summit of Mount Rainier have been used	for geodetic research	a
		as a refuge for marooned climbers	*b*
		by hibernating bears	c
		as cold storage for the kitchen at the lodge	d
5	Outside of Alaska, Mount Rainier	is the tallest mountain in the U.S.	a
		has the largest glacier system in the U.S.	*b*
		has the highest recorded wind in the U.S.	c
		is the most northerly volcano in the U.S.	d
6	Indians of the Northwest made baskets, clothing, and other articles from the fibrous bark of	red alder	a
		Douglas-fir	b
		western hemlock	c
		western redcedar	*d*
7	A bird that cracks seed with its heavy bill is the	evening grosbeak	*a*
		red-shafted flicker	b
		gray jay	c
		western tanager	d
8	Rotting logs, with their nutrients and moisture, often provide a starting place for seedlings of	true firs	a
		western hemlock	*b*
		Douglas-fir	c
		western white pine	d
9	In forest succession, hemlock tends to replace Douglas-fir	because hemlock is more resistant to fire, insects, and other destructive agents	a
		because hemlock lives longer than Douglas-fir	b
		because hemlock grows faster than Douglas-fir	c
		because hemlock seedlings survive better than Douglas-fir seedlings in the shade of a mature forest	*d*
10	Principal agents in reducing litter to humus are	fungi	*a*
		freezing and thawing	b
		insects	c
		rodents	d

[1/] In 1970, each of the 10 questions was used with four different arrangements of answer choices, providing versions with the correct answer in positions a, b, c, and d (correct choice is italicized).

each set (causing each version to be used in three of the 12 sets), and (3) all other questions were used just once. Within these constraints, questions were assigned to question sets at random.

Each question set was used until the "correct" counter registered at least 500 counts, insuring approximately even amounts of play for each set of questions. Data accumulated so rapidly that all question sets were used twice.

RESULTS

Proportions of correct answers for the 10 basic questions and four answer positions are shown in figures 4 and 5. These results correspond to interest patterns found in an interview study in which visitors at Ohanapecosh and four other visitor centers were asked to designate the exhibits they found most interesting.[1/] The exhibits shown by interviews to be the most and least interesting were those the recording quizboard showed to have the highest and lowest retention of information.

Statistical analyses were made to test for dependable differences (a) between specific groups of questions, (b) among all questions, and (c) among answer positions. These tests indicated that visitors remembered more from the exhibit with taped

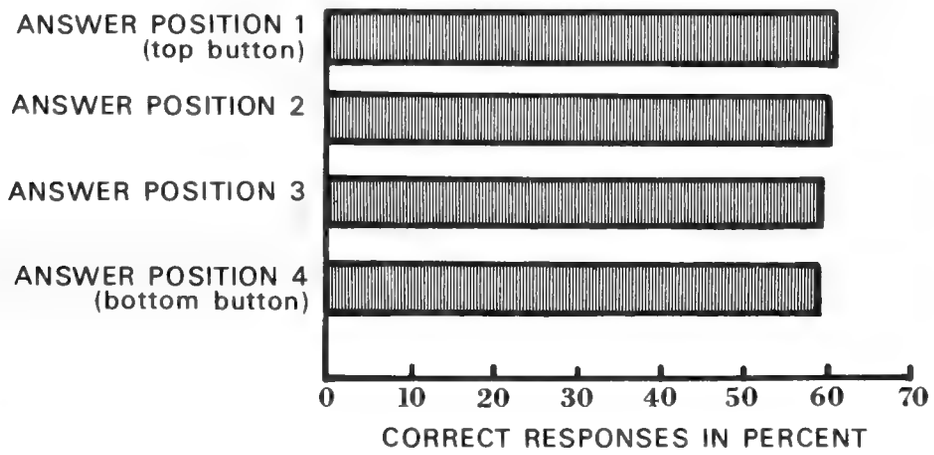


Figure 4.--*The effect of answer position for the recording quizboard. Data for all 10 questions having the correct answer in position 1 were combined, as were data for each set of 10 questions having correct answers in positions 2, 3, and 4, respectively. Since equal amounts of data were used for all 40 questions, this grouping averaged out the effects of content within each set of 10 questions.*

[1/] Randel F. Washburne. Visitor response to interpretive facilities at five visitor centers. Unpublished Master's thesis, University of Washington, Seattle. 91 p., 1971.

Question

The creature most likely to be found eating berries is the *grouse*.

If there were no flesh eating animals, the plant eating animals of the forest *would destroy their food supply by eating more than the forest could produce.*

Each National Park is established by act of Congress. Mount Rainier was established in *1899*.

Rotting logs, with their nutrients and moisture, often provide a starting place for seedlings of *western hemlock*.

Indians of the Northwest made baskets, clothing, and other articles from the fibrous bark of *western redcedar*.

Outside of Alaska, Mount Rainier has the *largest glacier system in the U.S.*

In forest succession, hemlock tends to replace Douglas-fir *because hemlock seedlings survive better than Douglas-fir seedlings in the shade of a mature forest.*

Principal agents in reducing litter to humus are *fungi*.

Caverns at the summit of Mount Rainier have been used *as a refuge for marooned climbers*.

A bird that cracks seed with its heavy bill is the *evening grosbeak*.

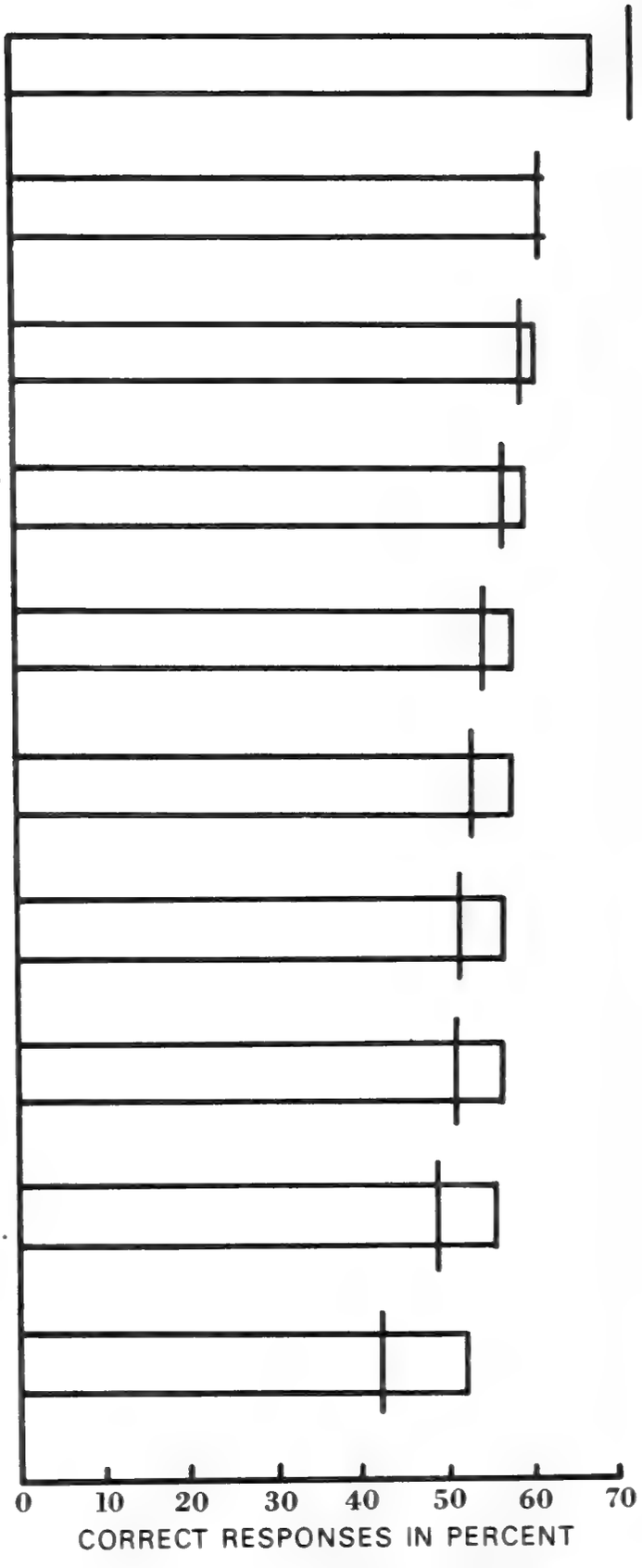


Figure 5.--*Results obtained by the recording quizboard, Ohanapecosh Visitor Center, Mount Rainier National Park, 1970. Bars indicate correct answer percentages obtained. Vertical lines show these percentages corrected for an assumed pattern in which one out of four plays was either random or systematic and another one out of four plays was correct because answers had been memorized during previous playing of the quizboard.*

narration (represented by questions 1 and 2) than from exhibits with written texts. Specifically, the tests permit us to be 99 percent sure that correct answer proportions for questions 1 and 2 combined are dependably higher than for all other questions combined. For comparisons among all questions, the tests permit us to be 95 percent sure that the correct answer proportion for question 2 is dependably higher than the correct answer proportion for question 4, 7, 9, or 10.

Tests indicate a 90-percent likelihood that the position of the correct answer affects the proportion of answers that are correct--some visitors push answer buttons systematically, as from top to bottom.

A particularly interesting result from this study was the popularity of the quizboard with children. Although the exhibits at Ohanapecosh are of excellent quality, the quizboard was the only item in the entire visitor center a child could manipulate. Within seconds after its installation, it became, for children, the most popular exhibit in the center.

DISCUSSION

Results show that the recording quizboard can tell the interpretive planner which questions are being answered correctly most often and can provide feedback that helps him determine the relative effectiveness of various exhibits or other interpretive efforts. Such feedback should be especially helpful for determining whether a change in a presentation makes it more effective or less so in conveying specific information to visitors.

The quizboard, however, cannot always identify the exact reason a presentation is effective. Interpretive planners often seem to use their most effective techniques for their most exciting stories. For example, at the Ohanapecosh Visitor Center, questions based on the diorama with a recorded message were answered more correctly than others. Yet this could be explained by the use of a taped message, by exciting subject matter (predators and prey), by exhibit size (largest in the building), by realism (unmatched by other exhibits in the building), or even by the possibility that visitors knew much of the subject matter before seeing the exhibit.

Because visitors who play the recording quizboard are a self-selected group, results will not represent the average of all visitors. Nevertheless, they may still provide the best available indication of what visitors are learning.

Differences between answers are reduced but not obscured by both repeated play and random or systematic play of the quizboard. At the Ohanapecosh Visitor Center, repeated play by children from the adjacent campground was especially common and accounted for a substantial portion of the total data. The usual pattern for a young "repeater" was to play until he learned the correct answers, play for several correct sequences, and then find someone else to watch him "get them all right."

To examine the effects of nonserious playing, I made computations for assumed amounts of such playing. For purposes of illustration, computations were made as if 25 percent of all answers were repeated plays in which all answers were correct

because of prior memorization and as if another 25 percent of the answers resulted from random or systematic playing.[2/]

The lines across the bars of figure 5 show results adjusted to exclude these assumed levels of nonserious play. Note that, in terms of correct answers, nonserious play does not change the order of questions but simply decreases differences between questions. This indicates that recording quizboards will give the most sensitive tests of interpretive effectiveness when located where they will be used primarily by transient visitors who are unlikely to play them repeatedly. In locations that encourage repeated play, as near overnight accommodations that hold visitors in an area for several days, results will be conservative and will show smaller differences than could be expected if all playing were serious.

Because playing the quizboard is obviously rewarding to many visitors, especially children, it can focus attention on specific information, thereby serving a teaching as well as a feedback function. The next step is to harness this reward pattern to enhance learning of more detailed concepts than are suited to quizboard question panels. A study of these possibilities is underway.

CONCLUSIONS AND RECOMMENDATIONS

1. Recording quizboards can be effective for obtaining feedback from visitors to indicate what they know or have learned. Quizboards should be especially good for detecting the effects of changes in interpretive facilities or presentations.

2. For the questions it presents, a recording quizboard can detect real differences in proportions of correct responses made during serious playing, even if many visitors either play it repeatedly after memorizing answers or play it randomly or systematically. The effect of nonserious play is to reduce differences between proportions of correct answers. However, the order of results will not be changed.

3. The positions of correct answers are likely to affect proportions of correct responses. Several versions of each question should therefore be written so that correct answers appear in each position for approximately the same number of responses. For four-choice questions, this requires four versions of each question. These should be rotated every 500 or 1,000 responses according to a randomly determined schedule.

[2/] Question 2 had a correct-answer ratio of 676/1000. If a quarter of all answers were correct because of prior memorization, the correct-answer ratio would change to (676 - 250) : (1000 - 250). Since all four answer positions were used an equal number of times, the effects of systematic and random answering would be identical. If another quarter of the responses were either random or systematic, one out of four answer choices (250/4 = 62.5) would be correct. This would further change the correct-answer ratio to (676 - 250 - 62.5) : (1000 - 250 - 250) = 0.727, an increase. At the other end of the scale, question 7 with a correct-answer ratio of 521/1000 would become (521 - 250 - 62.5) : (1000 - 250 - 250) = 0.417, a decrease. Subtracting other assumed amounts of nonserious answering also increases differences between correct-answer ratios for different questions.

4. When a recording quizboard is first used in a new setting, statistical tests should be made to determine how large differences between answers must be to be statistically significant. Thereafter, such tests should not be necessary. Approximately 1,000 responses for each version of each question should provide data with adequate stability for comparisons to be made between questions.

STATISTICAL ANALYSIS

Although chi-square analysis was originally planned for the recording quizboard, observations were not suitably independent. This lack of independence resulted from repeated playing by some individuals and from the fact that most people answered all four questions.

Because chi-square analysis was not appropriate, an analysis of variance was made. In this, the ratio of right answers to total answers was computed for each version of each question, giving 40 ratios (four versions each for 10 questions). Each ratio resulted from approximately 1,000 answer choices for the version and question involved. Although this does not seem to provide efficient use of each observation, large numbers of observations are easily obtained.

Analyses were made both with and without weighting for the number of observations on which each ratio was based. Results of these analyses were essentially identical, and only the unweighted analysis is reported (table 2).

Table 2.--*Analysis of variance for quizboard data, Ohanapecosh Visitor Center, 1970*

Source	d.f.	Sum of squares	Mean squares	F	P
Questions	9	0.06372	0.00708	3.91	<0.01
Answer positions	3	.01414	.00471	2.61	<.10
Error	27	.04887	.00181		
Total	39				

This analysis permits us to be 99 percent sure that means for the ratios of right answers to total answers differ among the questions. The analysis also permits us to be 90 percent sure that means of these ratios differ according to the position of the correct answer.

Comparisons

Designed comparisons were made to test for differences between questions based on three different patterns of exhibits: a diorama with recorded narration, 3-D exhibits

with text labels, and flatwork exhibits with text labels. Coefficients for the comparisons are shown in figure 6.

Of the nine designed comparisons, two were significant at 95 percent or higher probability: Comparison 1 showed that the two questions based on the diorama with recorded narration had significantly more correct answers than the eight questions based on text; comparison 9 showed that, for information presented on text labels in exhibits combining both flatwork and 3-D elements, visitors gave the correct answer to a question on Indians significantly more often than to a question on the evening grosbeak. However, since the grosbeak was a minor element in a large display case, no generalization seems justified by the significant result for the comparison.

In addition to the designed comparisons, all comparisons among means for the 10 answer ratios were made using the Tukey test.[3] In this, the minimum significant difference D was computed as

$$Q\sqrt{\text{error mean square/number of observations per mean}} = 4.88\sqrt{0.00181/4} = 0.1039$$

where Q is a table value for 10 treatments and 27 degrees of freedom.

Only four differences between means exceeded this value. These were as follows:

	Question 7	Question 4	Question 10	Question 9
Question 2	0.1552	0.1215	0.1086	0.1067

Comparison	Coefficients										
	Audio		3-D only and text			3-D plus flatwork and text			Flatwork and text	
Question	1	2	3	4	5	6	7	8	9	10
Mean	.62195	.67628	.60960	.55475	.57867	.58540	.52105	.59730	.56958	.56770
1	+4	+4	-1	-1	-1	-1	-1	-1	-1	-1
2	+1	-1								
3			+1	+1	+1	+1	+1	+1	-3	-3
4			+1	+1	+1	-1	-1	-1		
5									+1	-1
6			+1	+1	-2					
7			+1	-1						
8						+1	+1	-2		
9						+1	-1			

Computations for comparisons 1 and 9, using procedures from p. 329-332 of George W. Snedecor (Statistical Methods, 5th ed., Iowa State College Press, Ames. 1956). (Note that means are multiplied by 4 to convert them to sums.)

Comparison 1: Sum of squares $= \frac{[4(2.4878)+4(2.70512)-2.4384-2.2190-2.31468-2.3416-2.0842-2.3892-2.27832-2.2708]^2}{4(40)}$

$= 0.03707 \qquad F = \frac{0.03707}{0.00181} = 20+ \qquad p < 0.01$

Comparison 9: Sum of squares $= \frac{(2.3416-2.0842)^2}{4(2)}$

$= 0.00828 \qquad F = \frac{0.00828}{0.00181} = 4.5+ \qquad P < 0.05$

Figure 6.--*Designed comparisons and orthogonal coefficient sets for recording quizboard data.*

[3] George W. Snedecor. Statistical methods, p. 251-253. Ames, Iowa State Coll. Press, 1956.

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1972. The recording quizboard: a device for evaluating interpretive services. USDA Forest Serv. Res. Pap. PNW-139, 12 p., illus. Pacific Northwest Forest and Range Experiment Station, Portland, Oregon.

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2. Development and evaluation of alternative methods and levels of resource management.
3. Achievement of optimum sustained resource productivity consistent with maintaining a high quality forest environment.

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The FOREST SERVICE of the U.S. Department of Agriculture is dedicated to the principle of multiple use management of the Nation's forest resources for sustained yields of wood, water, forage, wildlife, and recreation. Through forestry research, cooperation with the States and private forest owners, and management of the National Forests and National Grasslands, it strives — as directed by Congress — to provide increasingly greater service to a growing Nation.